US006356530B1

(12) **United States Patent**
Tomaszewski et al.

(10) **Patent No.: US 6,356,530 B1**
(45) **Date of Patent: Mar. 12, 2002**

(54) **NEXT HOP SELECTION IN ATM NETWORKS**

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **08/862,915**

(22) Filed: **May 23, 1997**

(51) **Int. Cl.**[7] **H04L 12/26**

(52) **U.S. Cl.** **370/232**; 370/397

(58) **Field of Search** 370/395, 397, 370/399, 227, 230, 232, 233, 234

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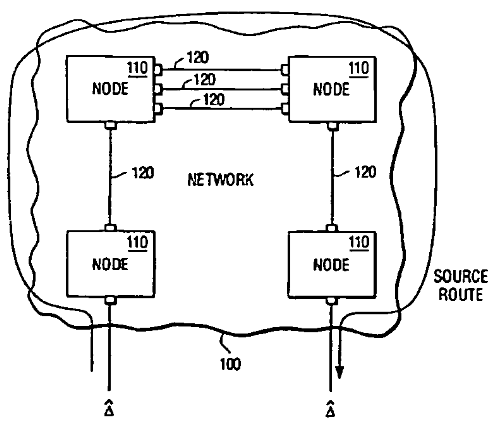
(57) **ABSTRACT**

The invention provides a method and system for selecting one particular interface between a pair of adjacent nodes in an ATM network for assignment to a call in that network. The cell rate available on each possible interface is examined and compared with the cell rate expected for the call, and one of the interfaces is selected and assigned responsive to those cell rates. (1) The interface can be chosen which preserves the maximum remaining cell rate for future calls. (2) The interface with the highest-speed available link can be chosen, so long as cell rate capacity is available on that interface for the call.

22 Claims, 2 Drawing Sheets



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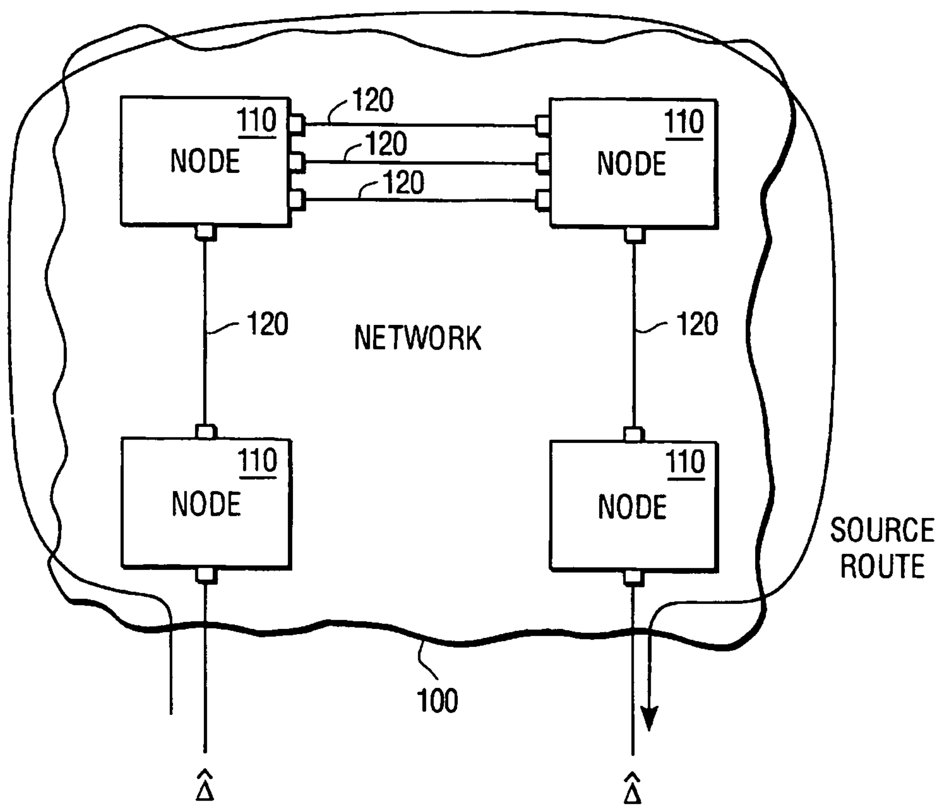
120
110
NODE
120
120
110
NODE
120
NETWORK
120
110
NODE
110
NODE
SOURCE
ROUTE
100

FIG. 1

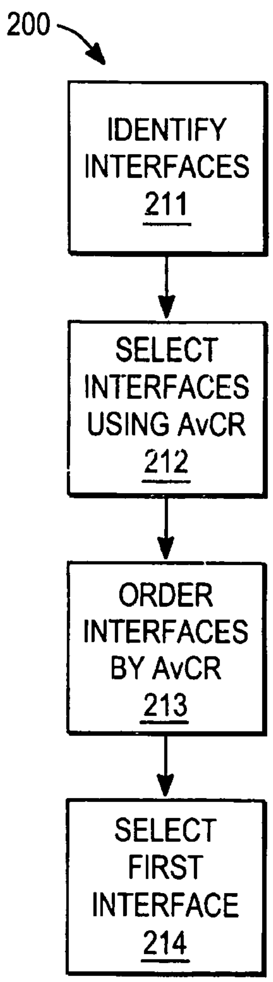

FIG. 2

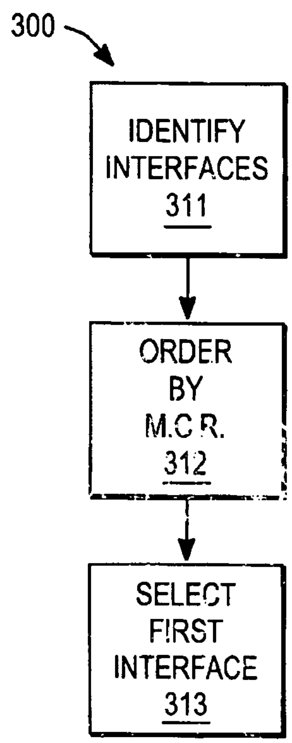

FIG. 3

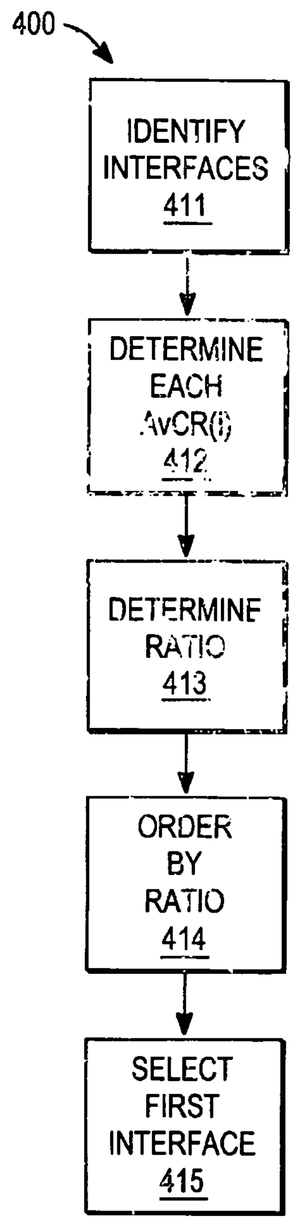

FIG. 4

NEXT HOP SELECTION IN ATM NETWORKS

BACKGROUND OF THE INVENTION

1. Field of the Invention

The invention relates to ATM networks.

2. Related Art

In known ATM systems, each call is routed in a virtual circuit which is specified by the sending node. This circuit includes a plurality of ATM switches in a virtual circuit from the sending node to the receiving node. If two adjacent nodes in the virtual circuit have more than one interface connecting them, one of the plurality of interfaces must be specifically chosen and assigned to the call.

In some instances, the interface is specified by the sending node. However, when the particular interface is not specified by the sending node, the two adjacent nodes must select one of the plurality of interfaces. In known ATM systems, one interface is selected by round-robin assignment. While this method is effective to unambiguously select one of the plurality of interfaces, it has the drawback that the selected interface can be inappropriate for optimal call routing.

Accordingly, it would be desirable to provide a method and system for selecting one particular interface, which is more appropriate for optimal call routing. This advantage is achieved in an embodiment of the invention in which relative bandwidth or another characteristic of the plurality of interfaces, and in which relative size or another characteristic of the call, are examined and taken into account when one interface is specifically chosen and assigned to the call.

SUMMARY OF INVENTION

The invention provides a method and system for selecting one particular interface between a pair of adjacent nodes in an ATM network for assignment to a call in that network. The cell rate available on each possible interface is examined and compared with the cell rate expected for the call, and one of the interfaces is selected and assigned responsive to those cell rates.

In a first preferred embodiment, the interface is chosen which preserves the maximum remaining cell rate for future calls. In a second preferred embodiment, the interface with the highest-speed available link is chosen, so long as cell rate capacity is available on that interface for the call.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 shows a block diagram of an ATM network.

FIG. 2 shows a process flow diagram of a first method for selecting an interface for assignment to a call.

FIG. 3 shows a process flow diagram of a second method for selecting an interface for assignment to a call.

FIG. 4 shows a process flow diagram of a third method for selecting an interface for assignment to a call.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

In the following description, a preferred embodiment of the invention is described with regard to preferred process steps and data structures. Those skilled in the art would recognize after perusal of this application that embodiments of the invention can be implemented using general purpose switching processors or special purpose switching processors or other circuits adapted to particular process steps and

data structures described herein, and that implementation of the process steps and data structures described herein would not require undue experimentation or further invention.

Inventions described herein can be used in conjunction with inventions described in the following application:

Application No. 08/863,031, filed May 23, 1997, in the name of the same inventors, entitled Call Size Feedback on PNNI Operation, which issued as U.S. Pat. No. 6,122,272 on Sep. 19, 2000 and is assigned to the same assignee as the present application.

This application is hereby incorporated by reference as if fully set forth herein.

ATM Network Including Multiple Interfaces Between Adjacent Nodes

FIG. 1 shows a block diagram of an ATM network.

An ATM network **100** includes a plurality of ATM nodes **110**, each of which is capable of transmitting ATM cells from a sending node **110** to a designated receiving node **110**. Each pair of adjacent nodes **110** has at least one, and possibly more than one, interface **120**. Each interface **120** is capable of transmitting ATM cells from a first adjacent node **110** to a second adjacent node **110**.

When an incoming call is received at the sending node **110**, that incoming call specifies a virtual circuit for the call, including the sending node **110**, the designated receiving node **110**, and a designated sequence of intermediate nodes **110**, for transmitting ATM cells for the call from the sending node **110** to the receiving node **110**. The incoming call may also specify other information about the call, such as a required cell transmission rate for the call.

When the virtual circuit for the call is set up, there may be one or more pairs of adjacent nodes **110** which have a plurality of interfaces **120** therebetween. In some cases, the incoming call will specify which of the interfaces **120** is to be included in the virtual circuit. In those case where the incoming call does not so specify, one of the methods shown herein is used to select one of the interfaces **120** for inclusion in the virtual circuit and thus for assignment to the call.

In preferred embodiments, the cell rate available on each possible interface is examined and compared with the cell rate expected for the call, and one of the interfaces is selected and assigned responsive to those cell rates.

First Method for Selecting Interface

FIG. 2 shows a process flow diagram of a first method for selecting an interface for assignment to a call.

A first method **200** applies to CBR (constant bit rate), RT-VBR (real time variable bit rate), and NRT-VBR (non-real time variable bit rate) traffic classes in an ATM network. The first method **200** includes the steps **211** through **214**.

At a step **211**, the method **200** identifies a plurality of interfaces **120** between the first adjacent node **110** and the second adjacent node **110**.

At a step **212**, the method **200** selects, from the interfaces **120** identified in the step **211**, the ones which have sufficient AvCR (available cell rate) for the incoming call.

At a step **213**, the method **200** orders the interfaces **120** selected in the step **212** in increasing order of AvCR.

At a step **214**, the method **200** selects the first interface **120** in an ordered list generated by the step **213**.

The first method thus choses the interface which preserves the maximum remaining cell rate for future calls.

Second Method for Selecting Interface

FIG. 3 shows a process flow diagram of a second method for selecting an interface for assignment to a call.

A second method **300** also applies to CBR (constant bit rate), RT-VBR (real time variable bit rate), and NRT-VBR (non-real time variable bit rate) traffic classes in an ATM network. The second method **300** includes the steps **311** through **313**.

At a step 311 (like the step 211 performed by the method 200), the method 300 identifies a plurality of interfaces 120 between the first adjacent node 110 and the second adjacent node 110.

At a step 312, the method 300 orders the interfaces 120 identified in the step 311 in decreasing order of Maximum Cell Rate.

At a step 313, the method 300 selects the first interface 120 in an ordered list generated by the step 312.

The second method 300 thus choses the interface with the highest-speed available link is chosen, so long as cell rate capacity is available on that interface for the call.

Third Method for Selecting Interface

FIG. 4 shows a process flow diagram of a third method for selecting an interface for assignment to a call.

A third method 400 applies to ABR (available bit rate) and UBR (unspecified bit rate) traffic classes in an ATM network. The third method 400 includes the steps 411 through 414.

At a step 411 (like the step 211 performed by the method 200), the method 400 identifies a plurality of interfaces 120 between the first adjacent node 110 and the second adjacent node 110.

At a step 412, for each interface 120*i* identified in the step 411, the method 400 determines the Available Cell Rate AvCR(i). The available cell rate is determined by subtracting, from the Maximum Cell Rate, the amount of bandwidth already reserved for that interface 120.

At a step 413, for each interface 120*i* identified in the step 411, the method 400 determines the ratio AvCR(i)/(Ni+1), where Ni is the number of actual "best effort" virtual circuits which are using the interface 120 i.

At a step 414, the method 400 orders the interfaces identified in the step 411 in decreasing order of the ratio determined in the step 413.

At a step 415, the method 400 selects the first interface 120 in an ordered list generated by the step 414.

The third method 400 thus choses the interface which best balances the load of multiple calls across multiple interfaces, after subtracting reserved bandwidth from each interface.

Alternative Embodiments

Although preferred embodiments are disclosed herein, many variations are possible which remain within the concept, scope, and spirit of the invention, and these variations would become clear to those skilled in the art after perusal of this application.

What is claimed is:

1. A method comprising:

receiving a request for a virtual circuit in a node of a switching network;

retrieving an available cell rate to accommodate said virtual circuit for each interface of a plurality of interfaces between said node and a second node of said switching network, said second node being adjacent to said first node;

selecting said each interface having said available cell rate higher than a transmission cell rate for said virtual circuit; and

selecting an optimum interface from said each interface selected for inclusion in said virtual circuit, said optimum interface having a lowest available cell rate of said available cell rate of said each interface selected.

2. The method according to claim 1, wherein said switching network is an ATM network accommodating a constant bit rate (CBR) traffic class.

3. The method according to claim 1, wherein said switching network is an ATM network accommodating a real time variable bit rate (RT-VBR) traffic class.

4. The method according to claim 1, wherein said switching network is an ATM network accommodating a non real time variable bit rate (NTR-VBR) traffic class.

5. A method comprising:

receiving a request for a virtual circuit in a node of a switching network;

retrieving an available cell rate to accommodate said virtual circuit for each interface of a plurality of interfaces between said node and a second node of said switching network, said second node being adjacent to said first node, said each interface having a transmission speed rate;

selecting said each interface having said available cell rate higher than a transmission cell rate for said virtual circuit; and

selecting an optimum interface from said each interface selected for inclusion in said virtual circuit, said optimum interface having a highest transmission speed rate of said transmission speed rate of said each interface selected.

6. The method according to claim 5, wherein said switching network is an ATM network accommodating a constant bit rate (CBR) traffic class.

7. The method according to claim 5, wherein said switching network is an ATM network accommodating a real time variable bit rate (RT-VBR) traffic class.

8. The method according to claim 5, wherein said switching network is an ATM network accommodating a non real time variable bit rate (NTR-VBR) traffic class.

9. A method comprising:

receiving a request for a virtual circuit in a node of a switching network;

retrieving an available cell rate to accommodate said virtual circuit for each interface of a plurality of interfaces between said node and a second node of said switching network, said second node being adjacent to said first node;

calculating a ratio for said each interface, as said available cell rate divided by at least one existent virtual circuit in said each interface; and

selecting an optimum interface from said each interface for inclusion in said virtual circuit, said optimum interface having a highest ratio of said ratio of said each interface.

10. The method according to claim 9, wherein said switching network is an ATM network accommodating an available bit rate (ABR) traffic class.

11. The method according to claim 9, wherein said switching network is an ATM network accommodating an unspecified bit rate (UBR) traffic class.

12. A system comprising:

a first node in a switching network to receive a request for a virtual circuit; and

a second node in said switching network, adjacent to said first node and coupled to said first node through a plurality of interfaces;

said first node to retrieve an available cell rate to accommodate said virtual circuit for each interface of said plurality of interfaces, to select said each interface having said available cell rate higher than a transmission cell rate for said virtual circuit, and to select an optimum interface from said each interface selected, said optimum interface having a lowest available cell rate of said available cell rate of said each interface selected.

13. The system according to claim 12, wherein said switching network is an ATM network accommodating a constant bit rate (CBR) traffic class.

14. The system according to claim 12, wherein said switching network is an ATM network accommodating a real time variable bit rate (RT-VBR) traffic class.

15. The system according to claim 12, wherein said switching network is an ATM network accommodating a non real time variable bit rate (NTR-VBR) traffic class.

16. A system comprising:

a first node in a switching network to receive a request for a virtual circuit; and

a second node in said switching network, adjacent to said first node and coupled to said first node through a plurality of interfaces;

said first node to retrieve an available cell rate to accommodate said virtual circuit for each interface of said plurality of interfaces, said each interface having a transmission speed rate, to select said each interface having said available cell rate higher than a transmission cell rate for said virtual circuit, and to select an optimum interface from said each interface selected, said optimum interface having a highest transmission speed rate of said transmission speed rate of said each interface selected.

17. The system according to claim 16, wherein said switching network is an ATM network accommodating a constant bit rate (CBR) traffic class.

18. The system according to claim 16, wherein said switching network is an ATM network accommodating a real time variable bit rate (RT-VBR) traffic class.

19. The system according to claim 16, wherein said switching network is an ATM network accommodating a non real time variable bit rate (NTR-VBR) traffic class.

20. A system comprising:

a first node in a switching network to receive a request for a virtual circuit; and

a second node in said switching network, adjacent to said first node and coupled to said first node through a plurality of interfaces;

said first node to retrieve an available cell rate to accommodate said virtual circuit for each interface of said plurality of interfaces, to calculate a ratio for said each interface, as said available cell rate divided by at least one existent virtual circuit in said each interface, and to select said optimum interface having a highest ratio of said ratio of said each interface.

21. The system according to claim 20, wherein said switching network is an ATM network accommodating an available bit rate (ABR) traffic class.

22. The system according to claim 20, wherein said switching network is an ATM network accommodating an unspecified bit rate (UBR) traffic class.

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